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Universal Plug and Play Device Architecture

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Introduction

What is Universal Plug and Play?

Universal Plug and Play is an architecture for pervasive peer-to-peer network connectivity of intelligent appliances, wireless devices, and PCs of all form factors. It is designed to bring easy-to-use, flexible, standards-based connectivity to ad-hoc or unmanaged networks whether in the home, in a small business, public spaces, or attached to the Internet. Universal Plug and Play is a distributed, open networking architecture that leverages TCP/IP and the Web technologies to enable seamless proximity networking in addition to control and data transfer among networked devices in the home, office, and public spaces.

UPnP is more than just a simple extension of the plug and play peripheral model. It is designed to support zero-configuration, "invisible" networking, and automatic discovery for a breadth of device categories from a wide range of vendors. This means a device can dynamically join a network, obtain an IP address, convey its capabilities, and learn about the presence and capabilities of other devices. DHCP and DNS servers are optional and are used only if available on the network. Finally, a device can leave a network smoothly and automatically without leaving any unwanted state behind.

UPnP leverages Internet components, including IP, TCP, UDP, HTTP, and XML. Like the Internet, contracts are based on wire protocols that are declarative, expressed in XML, and communicated via HTTP. IP internetworking is a strong choice for UPnP because of its proven ability to span different physical media, to enable real world multiple-vendor interoperation, and to achieve synergy with the Internet and many home and office intranets. UPnP has been explicitly designed to accommodate these environments. Further, via bridging, UPnP accommodates media running non-IP protocols when cost, technology, or legacy prevents the media or devices attached to it from running IP.

What is "universal" about UPnP? No device drivers; common protocols are used instead. UPnP networking is media independent. UPnP devices can be implemented using any programming language, and on any operating system. UPnP does not specify or constrain the design of an API for applications running on control points; OS vendors may create APIs that suit their customer's needs. UPnP enables vendor control over device UI and interaction using the browser as well as conventional application programmatic control.

UPnP Forum

The UPnP Forum is an industry initiative designed to enable easy and robust connectivity among stand-alone devices and PCs from many different vendors. The UPnP Forum seeks to develop standards for describing device protocols and XML-based device schemas for the purpose of enabling device-to-device interoperability in a scalable networked environment. The UPnP Forum oversees a logo program for compliant devices.

The UPnP Forum has set up working committees in specific areas of domain expertise. These working committees are charged with creating proposed device standards, building sample implementations, and building appropriate test suites. This document indicates specific technical decisions that are the purview of UPnP Forum working committees.

UPnP vendors can build compliant devices with confidence of interoperability and benefits of shared intellectual property and the logo program. Separate from the logo program, vendors may also build devices that adhere to the UPnP Device Architecture defined herein without a formal standards procedure. If vendors build non-standard devices, they determine technical decisions that would otherwise be determined by a UPnP Forum working committee.

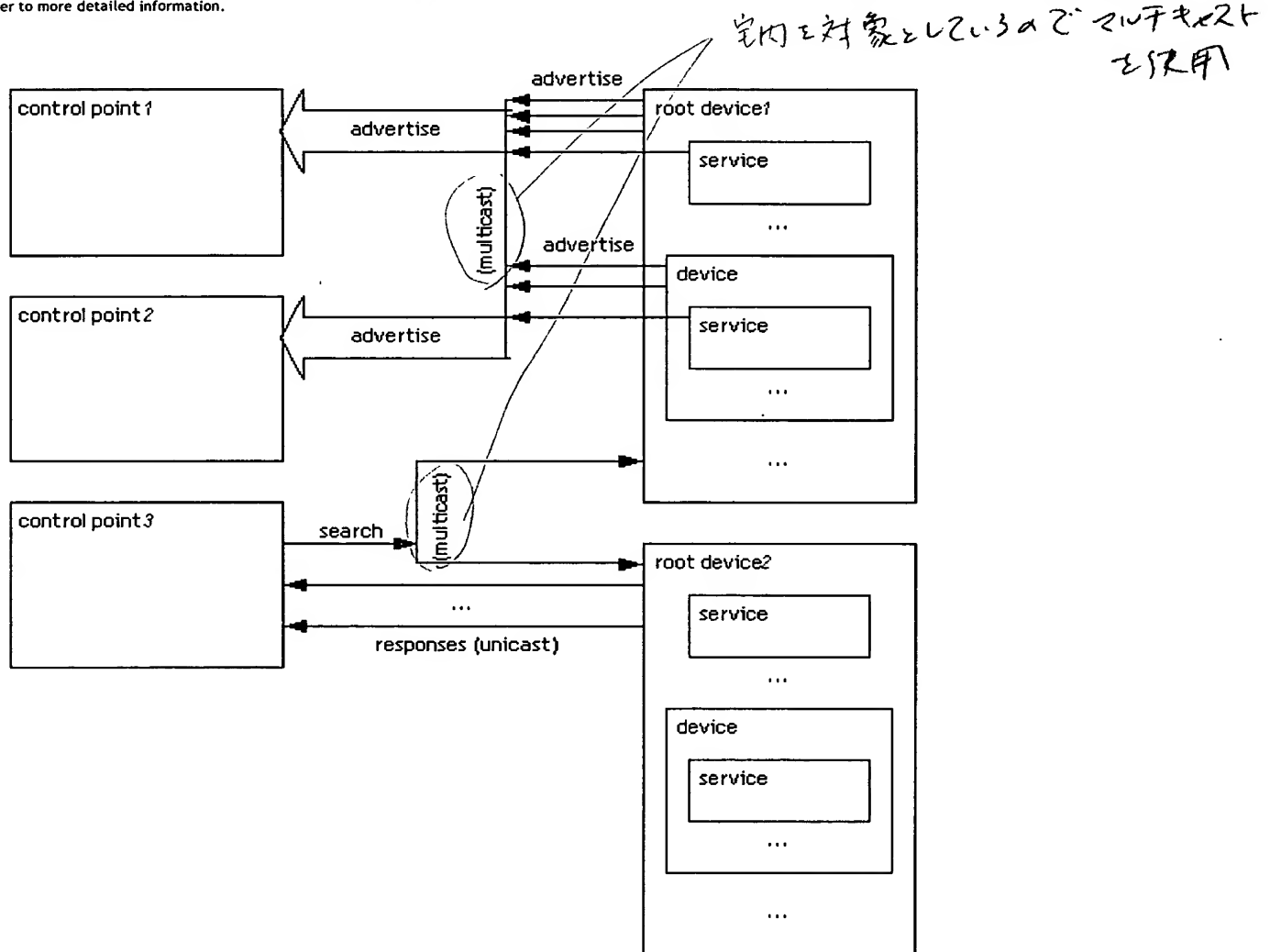
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1. Discovery

Discovery is Step 1 in UPnP networking. Discovery comes after addressing (Step 0) where devices get a network address. Through discovery, control points find interesting device(s). Discovery enables description (Step 2) where control points learn about device capabilities, control (Step 3) where a control point sends commands to device(s), eventing (Step 4) where control points listen to state changes in device(s), and presentation (Step 5) where control points display a user interface for device(s).

Discovery is the first step in UPnP networking. When a device is added to the network, the UPnP discovery protocol allows that device to advertise its services to control points on the network. Similarly, when a control point is added to the network, the UPnP discovery protocol allows that control point to search for devices of interest on the network. The fundamental exchange in both cases is a discovery message containing a few, essential specifics about the device or one of its services, e.g., its type, identifier, and a pointer to more detailed information.



When a new device is added to the network, it multicasts a number of discovery messages advertising its embedded devices and services. Any interested control point can listen to the standard multicast address for notifications that new capabilities are available.

Similarly, when a new control point is added to the network, it multicasts a discovery message searching for interesting devices, services, or both. All devices must listen to the standard multicast address for these messages and must respond if any of their embedded devices or services match the search criteria in the discovery message.

To reiterate, a control point may learn of a device of interest because that device sent discovery messages advertising itself or because the device responded to a discovery message searching for devices. In either case, if a control point is interested in a device and wants to learn more about it, the control point must use the information in the discovery message to send a *description* query message. The section on Description explains description messages in detail.

When a device is removed from the network, it should multicast a number of discovery messages revoking its earlier announcements, effectively declaring that its embedded devices and services will not be available.

To limit network congestion, the time-to-live (TTL) of each IP packet for each multicast message must default to 4 and should be configurable.

Discovery plays an important role in the interoperability of devices and control points using different versions of UPnP networking. The UPnP Device Architecture (defined herein) is versioned with both a major and a minor version, usually written as *major.minor*, where both *major* and *minor* are integers. Advances in minor versions must be a compatible superset of earlier minor versions of the same major version. Advances in major version are not required to be supersets of earlier versions and are not guaranteed to be backward compatible. Version information is communicated in discovery and description messages. In the former, each discovery message includes the version of UPnP networking that the device supports. As a backup, the latter also includes the same information. This section explains the format of version information in discovery messages and specific requirements on discovery messages to maintain compatibility with advances in minor versions.

The standard multicast address, as well as the mechanisms for advertising, searching, and revoking, are defined by the Simple Service Discovery Protocol (SSDP). The remainder of this section explains SSDP in detail, enumerating how devices advertise and revoke their advertisements as well as how control points search and devices respond.